Incorporating "The Illuminating Engineer."

Light and Lighting

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Edited by J. STEWART DOW

Telephone: ABBey 5215

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Standards of Lighting in Factories

ABOUT 1837 the First Factory Act was introduced. In 1937—just a century after—a general requirement of "adequate and suitable lighting" was inserted for the first time.

Now we have another advance, the Report of the Departmental Committee (see pp. 293—294) specifying simple specific rules of good industrial lighting.

Sufficient general lighting (minima of 1 foot-candle over interior working areas, 0.5, foot-candle over other parts, 0.1 foot-candle out of doors); avoidance of glare (limiting positions of sources brighter than 10 candles per square inch); elimination of troublesome shadows and flicker.

All this without prejudice to the higher values of illumination required for carrying on all but the very simplest kind of work required in Section 5 (i) of the Act, but not yet specified in detail (reserved for a further report).

A good start. These values are "effective legal minima," necessarily much below "recommended good practice." But if even these legal minima can be secured in every factory and workshop in the land, what an advance will have been made!

Leeds Leads the Way

First Annual Dinner and Dance

This pleasant event on November 18, the first of its kind, served to celebrate the granting of official status to the I.E.S. North Midland Centre, which comes into effect on January 1, 1939. Mr. Councillor H. W. Sellers, chairman of the Centre, presided at Powolny's, Leeds, where the dinner took place. In proposing "The Guests" he made special reference to the Deputy Lord Mayor of Leeds (Mr. Councillor J. Tait), who—so it was averred—on entering the Council asked to be placed on the Watch Committee, but in view of the reason given for that desire (that he would be able to visit theatres), was placed on the Blind Committee! Mr. Sellers also welcomed Mr. W. J. Jones (vice-president) and Mr. J. S. Dow (hon. secretary), who had come up from London to attend the gathering.

Mr. Tait, in responding, complimented the Society on the fine work it was doing, especially in connection with safety on the roads, and congratulated the Centre on its chairman, Mr. Sellers, who during the past few years had done such excellent work as chairman of the city's A.R.P. Committee.

Mr. W. J. Jones, who also responded to the toast, gave expression to the pleasure and satisfaction with which the parent body had witnessed the rapid progress of the North Midland Local Centre. He mentioned one or two steps which the Council had taken to promote closer touch with the various local centres. In lighter vein he recalled some amusing examples of growth of knowledge on lighting, and concluded by congratulating the Centre on deciding to admit ladies to its annual dinner—in which connection he repeated a toast addressed to them and stated to be of Swedish origin, which other members may like to borrow for use on similar future occasions.

Dancing followed the dinner, in the course of which the "Lambeth Walk" (North Midland version) was executed with enthusiasm.

The Menace of the Sun

Some remarks of Mr. W. J. Jones on the above occasion in regard to early inventors of "X-ray-proof underclothing" recall to mind fears of the dangers of ultra-violet light alleged to be present in electric lamps when first introduced. Later public opinion swung in the opposite direction. Apparently accepting the Turkish proverb, "Of a good thing one cannot have enough," people came to regard exposure to ultra-violet radiation as a panacea. Now, apparently, the pendulum has begun to reverse. Physicians warn enthusiasts against excessive doses of sunlight. An investigation has been set on foot by the Union of South Africa, where the belief is held that sunshine has a degenerating influence on Nordic stock. Whilst insufficient sunlight is doubtless prejudicial, excess may also be bad, as seems to be confirmed by the premature ageing and lack of stamina of some of the coloured races.

Visit to Dufay-Chromex Laboratories

The attention of members of the Illuminating Engineering Society is drawn specially to the above visit, arranged by the Photometry Section, to take place on January 31. Members will assemble at the works at Elstree, at 7 p.m. Light refreshments will be available, after which there will be a tour of the laboratories and works, and a talk on colour photography, and modern methods of manufacturing colour-sensitive materials will be given by Mr. C. H. Beale.

The visit affords an opportunity of seeing something of this fascinating colour work, in which there have been important recent developments. Members who wish to take part will do well to get in touch with the hon. secretary of the section (Mr. K. F. Sawyer, Watson House, Townmead-road, Fulham, S.W.6) in good time before the event.

Further particulars will be announced later.

I.E.S. Meetings

N.B. *Unless otherwise announced all meetings commence at 7 p.m.*

LONDON.

Dec. 19th. Light in Relation to Production (T. E. Catten); *E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2.*

Jan. 10th. The Lighting of Cinema Auditoriums (E. Stroud and H. E. Weston); *Film House, Wardour Street, W.1.*

Jan. 17th. Discussion on Report of Department Committee on Factory Lighting; *Institution of Mech. Engrs., Storey's Gate, Westminster, S.W.1.*

Jan. 24th. The Relation Between the Illuminating Engineer and the Fittings Designer (H. Bright); *E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2.*

Jan. 27th. The Design of Street Lanterns (J. Bertram and R. Maxted); *Royal Society of Arts, 18, John Street, Adelphi, London, W.C.2.*

Jan. 31st. Visit to Dufay-Chromex Laboratories, *Elstree.* **(7 p.m.)**

MANCHESTER.

Jan. 18th. The Lighting Requirements of a Large Store (O. Waygood); *Engineers' Club, Albert Square.* **(7.15 p.m.)**

LEEDS.

Jan. 9th. Decorative Materials and Their Response to Light (R. O. Ackerley); *The Electricity Showrooms, The Headrow.*

GLASGOW.

Dec. 21st. Some Aspects of Gas Lighting; *"The Gordons," 19, Gordon Street.* **(7.30 p.m.)**

Jan. 18th. Photometers and Photometry (H. E. de Weerdt); *19, Gordon Street.* **(7.30 p.m.)**

DUBLIN.

Dec. 20th. Problems Night; *Engineers' Hall, 35, Dawson Street.* **(6.30 p.m.)**

Jan. 17th. Electric Filament Lamps (E. D. Mcalister); *Engineers' Hall, 35, Dawson Street.* **(6.30 p.m.)**

Standards of Lighting in Factories

Fourth Report of the Departmental Committee on Lighting in Factories*

INTRODUCTION.

The present report, the issue of which has been eagerly awaited by the lighting industry, is a sequel to recommendations made in previous reports presented in 1915, 1921, and 1922. The committee appointed to review these previous recommendations were Sir Duncan Wilson (Chairman), Mr. J. S. Dow, Mr. J. A. Gregorson, Miss Florence Hancock, Professor H. Hartridge, Dr. C. S. Myers, Sir John Parsons, Mr. W. Scholes, Mr. G. W. Thomson, Dr. J. W. T. Walsh, and Mr. H. C. Weston. Subsequently Dr. R. J. Lythgoe was appointed to take the place of Dr. C. S. Myers (resigned).

In the course of the investigation evidence was received from the Illuminating Engineering Society, the National Illumination Committee of Great Britain, the Electric Lamp Manufacturers Association, and the Institution of Gas Engineers. A statement was also received from the Air Raids Precautions Department of the Home Office. Twenty-three witnesses were examined. The recommendations ultimately proposed were forwarded to The National Confederation of Employers' Organisations, The Trades Union Congress General Council, and the Factory Inspectorate for comment.

In a historical survey of developments mention is made of the early research in photometry of Mr. A. P. Trotter and of the work of Mr. Leon Gaster, the founder of the Illuminating Engineering Society.

Great interest in factory lighting was taken by Sir Arthur Whitelegge, when Chief Inspector of Factories. The reports of the Chief Inspector for 1909, 1910, and 1911 attracted a considerable amount of attention. Following these reports a committee, with Sir Richard Glazebrook as chairman, was appointed to inquire into "conditions necessary for the adequate and suitable lighting of factories." (It is interesting to recall that the joint secretaries of this committee were Dr. C. C. Paterson and Mr. (now Sir Duncan) Wilson.)

The chief recommendations of this committee related to values of illumination and glare.

The former included 0.25 ft.c. over working areas, 0.4 ft.c. in foundries, 0.1 ft.c. in parts of factories outside working areas, and 0.05 ft.c. in open yards, etc.—all without prejudice to the illumination required for the work itself. In 1922 these values were supplemented by 3 ft.c. for "fine work" and 5 ft.c. for "very fine work" (not as a legal standard but as recommended practice).

In regard to glare angles of elevation of at least 20°, or, in the case of a person 6 ft. or less from the source, 30° were prescribed for sources of a brightness exceeding 5 candles per sq. in., and within a distance of 100 ft.

General recommendations in regard to the avoidance of glare in the form of reflected light, troublesome shadows, or flickering on the part of sources of light were also made.

Since the issue of the above reports important researches have been made by the Illuminating Engineering Society, the Illumination Research Committee (D.S.I.R.), the Medical Research Council, the Factory Department, etc., some of which are summarised in an appendix to the present report.

Previous Legislation on Factory Lighting.

Extracts from recent annual reports of the Chief Inspector of Factories are also quoted to show that, whilst substantial improvement in industrial lighting has been made in some directions, in others very unsatisfactory conditions still exist.

Adequate lighting for industrial purposes has been for many years compulsory in Austria, Belgium, Denmark, France, Germany, Holland, Italy, Switzerland, and the United States of America. In most cases the requirement is framed only in general terms, and in but a few countries, notably the United States and Holland, have specific minimum standards been laid down. In Great Britain legal provision has hitherto been limited to a few special cases (e.g., the use of woodworking machinery and horizontal milling machines, and on docks, buildings, chemical works, and shipbuilding yards—work of an especially hazardous nature). The Factories Act of 1937 introduced a statutory provision for the first time. Section 5 requires that "effective provision shall be made for securing and maintaining sufficient and suitable lighting, whether natural or artificial, in every part of a factory in which persons are working or passing." It is also laid down that the Secretary of State may, by regulations, prescribe a standard of sufficient and suitable lighting.

In the next section of the report attention is drawn to the influence on perception of such factors as size of object, duration of observation, degree of contrast, colour of object, and the amount of light available. There follows an explanation of technical terms and a discussion of such items as glare, daylight factor, and the causes and effects of unsatisfactory lighting. The latter include damage to eyesight and health, increased accident rate, insanitary conditions, prejudice to discipline, and diminished output and quality of work.

Recommendations: Artificial Lighting.

The recommendations made by the committee may be divided into those under the headings of "Adequacy" and "Suitability" respectively.

In regard to Adequacy, the following values are recommended as the minimum general illumination without prejudice to the illumination required for the work itself:—

WORKING AREAS

"Over the interior working areas of any factory the illumination at floor level, or at 3 ft. below the level at which work is carried on, shall not fall below 1 ft.c. without prejudice to the illumination required for the work itself."

INTERIOR PASSAGE AND ACCESS

"Over all interior parts of any factory, other than working areas, over which persons employed are

* Issued by His Majesty's Stationery Office, November, 1938. Price 1s., postage extra.

liable to pass, the illumination at floor level shall not fall below 0.5 ft.c."

EXTERIOR EMPLOYMENT, PASSAGE, AND ACCESS

"Over all open yards, passages, roadways, and other open places in a factory, upon which persons are employed or over which they are liable to pass, the illumination at ground level or at other level of employment or passage, shall not fall below 0.1 ft.c., without prejudice to the illumination required for the work itself, or for the adequate lighting of dangerous parts and places or other emergency.

"The Chief Inspector of Factories shall have power to approve a lower standard in appropriate cases."

Processes Requiring Discrimination of Fine Detail.

The Committee appreciates the need for standard legal minimum of illumination for industrial purposes involving discrimination of detail. In the Third Report (1922) minimum standards of 3 ft.c. and 5 ft.c. were suggested as recommended practice, and a number of processes were grouped into one or other of these schedules. But the modern range of such processes is so complex that provision by schedule is difficult. It appears possible to devise a scientific method of estimating the illumination adequate for any process from which an appropriate legal minimum standard might be deduced, and it is proposed to investigate such a method. Some time may, however, be necessary for the complete investigation of this intricate problem. The Committee therefore considered it expedient to make known their views in regard to general lighting without delay, in order that advantage might be taken of their conclusions in the immediate future.

For the guidance of those interested it is pointed out that evidence given by the various technical bodies consulted (summarised in an appendix to the Report) indicates that values considerably in excess of those recommended in the above-mentioned Report are now usual. For purposes of design reference may be made to the tables of recommended values for various purposes published by such bodies as the Illuminating Engineering Society and the Electric Lamp Manufacturers' Association.

Under the heading of Suitability the following recommendations are made:—

SUPPRESSION OF GLARE

"Where any light source in a factory is less than 16 ft. height above floor level, no part of the source or fitting having a brightness greater than 10 candles per square inch shall be visible to any person whilst normally employed within 100 ft. of the source, unless the angle of elevation from the eye to the source exceeds 20 degrees."

A brightness of 10 candles per square inch is approximately the brightest part of the naked flame of an ordinary paraffin wick lamp. The "angle of elevation" is the angle contained between the direct line from the eye to the source and a horizontal line through the eye in the same vertical plane.

The accompanying table illustrates the relationship between height of light source and its distance from a worker to comply with the minimum angle of cut-off of 20 degrees.

Height of source above floor level.	No part of the source or fitting of brightness greater than 10 candles per square inch should be visible at or beyond:—
Feet.	
6	2 ft. 9 in.
8	8 ,, 3 ,,
10	13 ,, 9 ,,
12	19 ,, 3 ,,
14	24 ,, 9 ,,
16	30 , 3 ,,

LOCAL LIGHTING

"All local light sources in a factory shall be provided with suitable shades of opaque material or other effective means by which they shall be completely screened from the eyes of every person employed at a normal working place."

REFLECTED GLARE

"Adequate means shall be provided, as far as reasonably practicable, by suitable screening or placing or other effective method to prevent discomfort or injury by the reflection of light from smooth or polished surfaces into the eyes of the worker."

AVOIDANCE OF EXTRANEOUS SHADOW

"Adequate means shall be taken, as far as reasonably practicable, to prevent the formation of shadows which interfere with the safety of, or cause discomfort to, any person employed."

PROHIBITION OF UNSUITABLE LIGHT SOURCES

"No light source which flickers or undergoes abrupt changes in candle power in such manner as to interfere with the safety or efficiency of any person employed shall be used for illumination of a factory."

This prohibition is not intended to apply to electric discharge lamps or other electric lamps on a supply frequency of 50 cycles or more, unless it is established that stroboscopic or other effects create discomfort or dangerous optical illusion. Nor are flares or other flickering light sources, for temporary use in cases of breakdown or emergency, intended to be prohibited.

Recommendations; Natural (Day) Lighting.

Whilst emphasising the importance of securing a maximum daylight illumination, and recording evidence that the daylight factor at table height should not be less than 0.2 per cent., the Committee does not advise any regulation on this point.

Conclusion.

In conclusion, the Report emphasises that the foregoing standards represent *the least* values of general lighting considered acceptable as effective legal minima, and that they should not be quoted as standards of recommended good practice.

High appreciation is expressed of the services of the secretary of the Committee, Mr. R. W. Daniel, and of the value of the experimental work undertaken by Mr. W. J. Jones at the E.L.M.A. Lighting Service Bureau.

The various appendices contain Summaries of Previous Recommendations and tabulated records of the proposals of the bodies giving evidence, which, as regards working illumination, approach closely to the I.E.S. "Recommended Values of Illumination." A final appendix contains a useful summary of recent investigations of lighting in industry.

NOTES ON ILLUMINATING ENGINEERING ABROAD

(Specially Contributed—H. L. J.)

United States.

Among other contributions at the recent Convention of the American Illuminating Engineering Society was one by Mr. W. B. Lancaster, who discussed "Illumination Levels and Eye Comfort Conditions." He pointed out that a mere increase of illumination value only partly satisfies comfort demands. The reaction to comfort conditions created by lighting, as well as by other lines, varies individually. Home lighting is distinguished from most other applications of lighting where the design of illumination arrangements can be based on a limited and fixed number of occupations. He issued a warning against carrying rises in illumination values too far, and advocated that time should be allowed for testing the comfort of such installations. The human eye is most comfortable under perfectly diffused light from the sky. It is, therefore, to be inferred that an even distribution of light is more essential than mere brightness. Mr. Lancaster confirms the views expressed by Luckiesh and Moss on quality of light, and stigmatises glare as the most detrimental fault to vision, even when present in the most subtle form.

Mr. Gjon Mili, in his paper, "Further Study in the Influence of Filament Form on Beam Characteristics with Deep Paraboloids," continues a contribution made three years ago. He refers to investigations of beam properties produced by lamps with the filament along the axis (so-called C.8) and those with the filament normal to the axis of the reflector (so-called C.6). The reflector used for the experiments was a 5-in. rhodium-plated parabolic reflector (f=$\frac{7}{8}$ in.) with an acceptance angle of 220° of a highly accurate contour. All measurements were made at 30 ft. distance, with the projected beam focused at the same distance, and with the aid of a calibrated photronic cell illumination meter. In general, it appears that the greater the filament mass placed coincident with or near the reflector axis the higher the maximum candle-power. However, the C.8 filament position gives a somewhat higher maximum candle-power than the C.6, due to the fact that the void space in the actual structures is relatively more prominent. It was also found that the candle-power is reduced as the length of filament is increased simply by stretching the coil. In such circumstances in the C.8 position the over-all beam spread is increased, whilst in the C.6 position the horizontal spread is increased. If the actual size of the filament is kept constant, but the length-to-width ratio increased by changing the pitch, it is again found that the maximum candle-power is increased to a greater extent with the C.8 position than with the C.6.

Germany.

The Convention of the German Illuminating Engineering Society took place at Munich during September 29 to October 1. Mr. F. zur Nedden, discussing safety on roads, summarised reports from England, France, U.S.A., and Germany. He stated that the initial point for research on street illumination should be conditions on wet roads. The system of silhouetting, summed up in the words "The night takes the daylight, but gives us the contrast," is becoming more and more internationally accepted. The importance of good street lighting in Germany was stressed by disclosing the fact that 300,000,000 reichsmarks (=£27,272,727) is the annual expenditure involved in damage caused by motor-car accidents.

Mr. H. G. Frühling described a new photo-electric colour-meter. This consists of a photo-electric cell, in front of which three different colour-filter sets can be placed. The spectral sensitivity of the cell can then be adjusted in accordance with the three basic sensitivity curves of the Young-Helmholtz three-colour theory of the eye, so as to comply with I.C.I. recommendations. The filter-glass combination consists of several bands of coloured glass, which, either superimposed on or placed beside each other, cover the actual surface of the cell. By moving these bands modification in selectivity can be secured. Measurements of coloured light sources made with this apparatus can be conducted more accurately and more quickly carried out than by other methods hitherto adopted. The apparatus has been developed by the author and Mr. Dresler.

Mr. N. Riehl reported on problems associated with raw material in the field of gas lighting. Manufacturers of gas mantles are endeavouring to make use of German artificial silk, and have already been successful in reducing the percentage or raw material imported from 3 per cent. to 0.5 per cent. This remaining fraction is involved in the use of thorium, which still has to be imported. Efforts to find substitutes for thorium have led to the discovery of the usefulness of certain rare earths as colouring substances for glass (such as Neophan).

Mr. R. Schulze dealt with the use of U.V. radiation in hygiene and progress made since its introduction. He stated that 85 per cent. of all practising physicians utilise sources of U.V. radiation instruments, and approximately one home in every 250 is equipped with such apparatus. In this connection it is interesting to learn that, in order to balance the lack of natural daylight and to neutralise the effects of so-called "lack of light" illness, a large-scale U.V. radiation installation was installed in the changing quarters of a mining company. The workers thus receive U.V. radiation during the time they were changing their clothes. This installation consists of thirty U.V. and sixty infra-red lamps. It is arranged to light three aisles, each approximately 12 yd. long.

Obituary

André Blondel

In the death of Professor André Blondel, which occurred in Paris on November 15, photometry has lost one of its great international figures. Born in 1883, André Blondel became a civil engineer, and was appointed Chief Engineer of Bridges and Highways in 1908, also filling a professorial position. Although undergoing a serious illness, by which his health was permanently affected, he continued to keep in touch with his many scientific and technical interests, remaining in joint control of lighthouses and beacons until 1927.

To illuminating engineers in this country his name is familiar through much early pioneering work on photometry, photometric nomenclature, prismatic reflectors, the electric arc, and street lighting. In connection with several of these subjects his work ran curiously on lines closely parallel with those followed by Mr. A. P. Trotter in this country. Much of his work helped to pave the way for the international understanding attained within recent years in various fields of illuminating engineering.

Revealing Objects on the Street by Night

A summary of three papers read at the meeting of the Illuminating Engineering Society held in the Lecture Theatre of the Institution of Mechanical Engineers on November 8th.

At the meeting of the Illuminating Engineering Society on November 8 three papers were read in which the authors dealt with various aspects of the problem of determining the effectiveness of any given street-lighting installation for rendering objects on the roadway visible at night. The whole of the work described was carried out for the Ministry of Transport Departmental Committee on Street Lighting when that Committee was investigating this very difficult question of the measurement of visibility.

Chief Factors Determining Visibility of Objects.

The first paper to be read was entitled "The Revealing Power of Street Lighting Installations," and was by Mr. J. M. Waldram, who started by drawing attention to the many factors which were involved in revealing an object on the roadway. There were, he said, the objective factors, such as background brightness, object brightness, the geometry of the street, the arrangement of sources, etc., and the subjective factors, particularly the state of adaptation of the eye and glare. Since many of these factors depend on the position of the observer, so does the revealing power, and it is therefore necessary, for practical purposes, to choose a single viewpoint in the installation. This done, the next step is to determine the contrast between a typical object and its background, i.e., that portion of the road against which it is seen from the selected viewpoint. This contrast depends on the brightness of the object and the brightness of the roadway and these two quantities have to be considered separately.

The brightness of all parts of the road surface, as seen from the selected viewpoint, can be most conveniently obtained by the method of photographic photometry, and a photograph of the street can be contoured to show which areas of the surface have a brightness lying within any selected range of values.

Since objects on the road are normally seen by silhouette (dark on light) the next step is to find out how much darker than its background an object must be in order that it may be clearly revealed to a motorist travelling at normal speed. This information is available as the result of an investigation described in the paper by Mr. Dunbar (see p. 297) and the way is therefore open to calculate the greatest brightness which an object may have if it is to be seen against any particular portion of the road surface.

Now the brightness of the object depends on its reflection factor and on the illumination, and in the practically most important case of an object of which the surface observed is approximately vertical, the brightness of any given object can be obtained from a curve showing the illumination of a vertical surface at all point in a span of the installation. The one remaining variable is the reflection factor of the object. The question now is "What percentage of the total number of objects met with on the road have reflection factors lying within any given range?" This question can be answered from the data given in the paper by Mr. Smith (see p. 297), and the problem of calculating what fraction of objects on the road will, on the average, be revealed against a given patch of road surface can then be solved.

A Typical Example.

The method is, perhaps, best explained by means of an example. If the brightness of the patch of roadway considered is 0.1 equivalent foot-candles, Mr. Dunbar's investigation shows that an object, in order to be adequately revealed to a motorist travelling at 30 m.p.h., must have a brightness not exceeding 0.06 eq. ft.c. In order to find out how many objects have a brightness not greater than this it is necessary to remember that an object of *any* reflection factor may occur *anywhere* in a span of the installation. Therefore, the first step must be to find, from the curve of vertical illumination, a table showing for what percentage of the length of a span the illumination lies within each of a series of co-terminous ranges of values. Such a table is shown below for an imaginary installation.

Range of Vertical Illn. (f.c.)	0–0.15	0.15–0.2	0.2–0.3	0.3–0.4	0.4–0.5	0.5–0.8	Over 0.8
Percentage of Span	14	12	32	15	10	7	10

The next step is to find from Mr. Smith's data what percentage of the total number of objects on the road have reflection factors such that, within the respective ranges of illumination in the above table, their brightnesses will not exceed 0.06 eq. ft.c. These figures may again be tabulated as follows:—

Range of Vertical Illn. (f.c.)	0–0.15	0.15–0.2	0.2–0.3	0.3–0.4	0.4–0.5	0.5–0.8	Over 0.8
*Refl. Factor less than	80	34	24	17	13	9	6
Percent'ge of Objects	100	98	93	87	79	71	58

Remembering, once again, that *any* object may occur anywhere within a span, it follows that the total chance of encountering a brightness equal to or less than the prescribed figure (0.06 eq. ft.c.) is obtained by multiplying the corresponding figures in the bottom rows of the two tables and summing the results, i.e., the chance is $(14 \times 100 + 12 \times 98 + 32 \times 93 + 15 \times 87 + 10 \times 79 + 7 \times 71 + 10 \times 58)$ divided by 100 to bring it to a percentage. The answer is 87.3 per cent., and this is termed the "revealing power," i.e., the chance that an object will be revealed on any portion of the road surface which has a brightness of 0.1 eq. ft.c. or over.

Overall Figures for Revealing Power.

To obtain an overall figure for the revealing power of the whole street it is necessary to carry out a calculation like the above for each of a series of co-terminous ranges of values of street surface brightness. Each individual revealing power is weighted according to the probability that an object will be seen against a patch of road which has a surface brightness within the corresponding range of values, and the average thus obtained is the required figure of "overall" revealing power. Mr. Waldram points out, however, that by far the most useful information is obtained by taking the photograph of the street, contoured for brightness, and substituting for the brightness figures the corresponding figures of

* These figures are, of course, obtained by dividing 0.06 by the mean illumination in each range, e.g., 0.06/0.075 = 0.8 = 80%.

revealing power. For instance, in the photograph of the street installation chosen for the example worked above, the brightness contour marked 0.1 eq. ft.c. would be re-labelled 87.3 per cent. and so on. If desired, fresh contours can, of course, be drawn at convenient integral values of revealing power. An example is shown in Fig. 1.

Necessary Brightness Contrast.

The paper read immediately after Mr. Waldram's was by Mr. C. Dunbar, and was entitled "Necessary Values of Brightness Contrast in Artificially Lighted Streets." This paper, as already mentioned, described an investigation carried out with the object of determining the contrast (here defined as the difference of brightness) necessary to reveal an object in silhouette against a background of given brightness. Mr. Dunbar used a "jury" method and found a very satisfactory measure of agreement between individuals asked to drive along a road at 30 m.p.h. and to state whether or not they considered a given contrast between a vertical disc and its background (a very uniform road surface) was sufficient to make the disc obvious enough for safety. This "critical contrast" was determined for a whole range of values of background brightness from approx. 0.03 to 1 eq. ft.c. and his final results, although given in the form of a curve, may be quoted as follows (all values in eq. ft.c.):—

Background Brightness	0.03	0.05	0.1	0.3	1.0
Critical Contrast	0.016	0.024	0.04	0.11	0.34
Brightness of Object	0.014	0.026	0.06	0.19	0.66

From this table it will be seen that, as might be expected, the percentage difference of brightness necessary to make an object visible against its background becomes greater as the background brightness diminishes; for a background brightness of 1 eq. ft.c. the difference required, is 34 per cent., while for a background brightness of 0.05 eq. ft.c. the difference must be at least 48 per cent. In the case of the worked example of revealing power given earlier in this article the brightness selected was 0.1 eq. ft.c., for which the critical contrast is seen from the table above to be 40 per cent. Therefore an object, to be clearly revealed against this background, must not have a brightness of more than 0.06 eq. ft.c.

The values of critical contrast tabulated above were obtained under conditions in which glare was absent, or at least negligible. The effect of the glare due to the street lamps can be calculated by a method described by Mr. Dunbar in his paper, but the calculation is somewhat laborious, and the magnitude of the correction is usually small, except in the case of installations which are obviously very glaring.

A very interesting conclusion drawn by Mr. Dunbar from his experiments is that, for an installation of given characteristics (i.e., for a given distribution of road surface brightness), and in the absence of glare, increasing the brightness level raises the revealing power only so long as some portion of the road surface has a brightness below 0.1 eq. ft.c. When the whole road has a brightness in excess of this value further increase has no effect on the revealing power. It would be interesting to see this conclusion tried out in practice.

Statistics on Revealing Power.

The third of the papers read was by Mr. F. C. Smith, and was entitled "Reflection Factors and Revealing Power." Mr. Smith described a very extended series of measurements of the reflection factors of pedestrians' clothing. Since, as he pointed out, *any* part of a pedestrian might be seen against a particular portion of the street surface as background, it was necessary to measure the reflection factors of coats and trousers separately (for men) and of coats and stockings in the case of women. The results for each of these four groups are given separately in the paper, and for the women's clothing there are separate curves referring respectively to summer and winter garments. In order to obtain a fair mean curve a weighting system was adopted, taking into account both the relative numbers of men and women pedestrians (1.4 to 1), and the fact that, generally speaking, trousers and stockings form a much smaller proportion of the silhouetted figure than coats. Some idea of the final curve obtained in this way is given by the following table, in which each figure in the upper line shows the percentage of pedestrians which have a reflection factor not exceeding the figure immediately below.

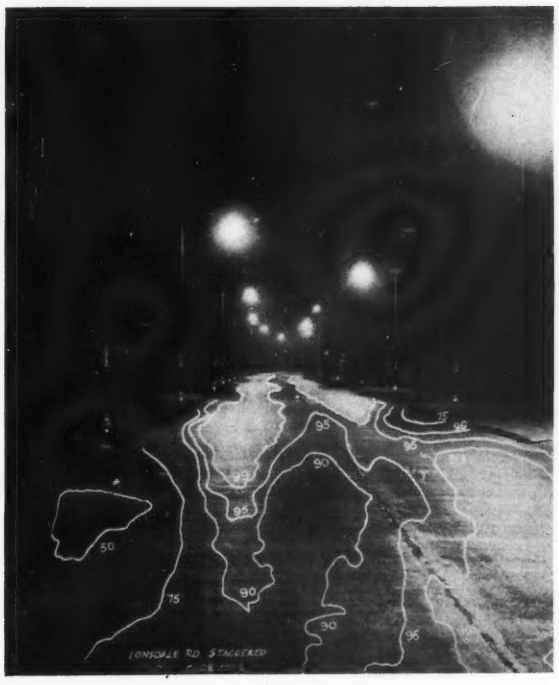

Fig. 1. A typical illustration from Mr. Waldram's paper showing an installation with staggered arrangement of lights. Test Point Illumination 0.08 foot-candles.

Percentage of Pedestrians	29	52	66	73	83	91	98	100
Reflection Factor (%)	3	5	7	10	15	20	30	50

It is interesting to notice, in passing, how closely the figures given by Mr. Smith agree with those found by investigators in other countries—evidently the fashions in clothing are universal in at least the one matter of reflection factor!

The reading of the three papers briefly summarised above was followed by a very lively discussion, in which a number of useful points were brought out and subsequently dealt with by the authors in their replies.

Dr. C. C. Paterson, the opening speaker, pointed out how the three papers together constituted a statistical framework, on the basis of which it should be possible to establish at least approximate standards in the future. Dr. J. W. T. Walsh and Mr. J. S. Dow referred to the influence of coloured light, the colour of the light yielded by modern illuminants, and Mr. A. Cunnington and others emphasised the importance of glare in relation to visibility.

Outdoor Photometry

In what follows we give a summary of the introductory address on the above subject, delivered by Mr. J. S. Dow at the meeting of the Photometry Section of the Illuminating Engineering Society on November 29, and the ensuing discussion.

Meetings of the I.E.S. Photometric Section are usually regarded as rather specialised and staid affairs in comparison with the more lively gatherings of some other sections. The last meeting of the photometric section, held in the lecture theatre of the Junior Institution of Engineers (London) on November 29, was, however, both entertaining and instructive.

The Purpose of Photometry.

In an introductory address on "Outdoor Photometry," Mr. J. S. Dow recalled that the essential purpose of photometry was to measure the "power of creating brightness" of sources of light—not such secondary qualities as "power of revealing detail." Effects associated with the Purkinje phenomenon, which had an important influence on apparent brightness at low illuminations, could not be avoided nor ignored; but sharpness of outline was associated with acuteness of vision and chromatic aberration of the eye and was not a quality to be determined by photometric tests.

Outdoor photometry, the lecturer pointed out, comprised a wide field—measurements of daylight, moonlight or starlight, tests of searchlights and beacons, and atmospheric transmission, and telephotometry. He proposed to deal only with artificial light and with installations in which light was used to render objects and surroundings visible, to meet everyday demands.

Streets, Roads, and Squares.

In connection with such installations, however, a further distinction was necessary. On a main traffic road, with a polished surface, the aim was to produce a ribbon of light against which objects were seen in silhouette. Mr. Dow said that he much admired the skill, ingenuity, and invincible patience of the chairman (Mr. J. M. Waldram) and others who had developed a special technique—involving detailed observations of road-brightness aided by scientific photography—for such problems. Yet this was a specialised process and did not supersede the more fundamental and time-honoured process of measuring illumination. Measurements of illumination still formed the main method of attack in connection with side streets and residential roads with less polished surfaces; country roads, lanes, routes, and pathways, often rough and possibly broken by ruts; public squares, playgrounds, subways; yards and open spaces adjoining factories, railways and docks; aerodrome landing grounds.

In these cases it was often possible to achieve a very fair contrast between the illuminated object and its background, usually horizontal and more distant from the source. One was often concerned with the detection and recognition of objects at close quarters —one needed, for example, to be able to read notices and recognise faces. Measurements of illumination were thus necessary to define the conditions—but how far was it possible to diminish the enormous work involved in surveying these large areas?

Difficulties of Outdoor Photometry.

Turning next to difficulties in connection with outdoor photometry, Mr. Dow contrasted the improved instruments of to-day with the early types introduced nearly thirty years ago, which were not equipped with ammeters or voltmeters. He recalled awkward incidents during tests, arising from uncertainty whether the accumulator would last out. In modern instruments greater precision was obtained, but it was significant that according to the B.S.I. specification an accuracy within 10 per cent. was not expected for outdoor conditions. Undoubtedly one of the most difficult elements was the test-plate, in view of the fact that with oblique light serious deviations from the cosine law might arise. The difficulty was rather accentuated with photo-electric instruments, which were also difficult to apply for outdoor measurements, as at present one could not—without using very elaborate and bulky apparatus—measure low illuminations with accuracy. Out of doors one might wish to record values running down to 0.01 ft.c. In the recently issued Home Office Report for Factory Lighting, 0.1 ft.c. was a specified minimum out of doors. Even for indoor work the simpler forms of photo-electric instruments were not sufficiently accurate for low readings. One could not, for example, check such values as the 0.5 and 1.0 ft.c. mentioned in the Home Office Report with an instrument on which there were no divisions below 10 ft.c.!

Effects of Colour.

Allusion was made to the difficult problem of comparing sources of different colour, acute in the case of the modern mercury and sodium discharge lamps. Whilst correction factors could be applied both to visual and photo-electric instruments, and fair consistency thus obtained, one did not avoid the fundamental difficulty that at low illuminations the comparative brightness of large areas illuminated by such sources might be very different from what photometric tests in the laboratory would suggest.

Before concluding this portion of the address, Mr. Dow referred to one possible, but little explored, cause of variations in readings of instruments—that due to differences in conditions of calibration. In the early days of photometry frequent checking was essential, and he had discovered that calibrations made at various accessible laboratories differed quite considerably. Even to-day there might be differences in the standards in use.

On the whole, however, the most formidable problems in outdoor photometry were associated with the *use* of the instrument. Avoiding casting a shadow of one's own body was not always so easy when there were several sources, nor was the elimination of stray light. (In this connection the author recalled the instructions in an appendix to the old B.S.I. specification for street lighting. He wondered how far the operator would succeed in eliminating stray light for each of the lamps in succession, and what relation the aggregate value deduced would bear to the actual illumination on the spot!) The importance of stray light was the greater because of the low illumination measured. Another difficulty, necessarily associated with photo-electric photometers, was reading the scale by the low faint light available. In instruments of the visual type the provision of a scale illuminated by the lamp in the instrument had sometimes been contrived. One ingenious type devised by Commander Haydn T. Harrison illustrated this method.

Atmospheric Absorption.

Atmospheric absorption, not merely on misty and foggy nights, but even in relatively clear weather, might often be considerable. One might meet simultaneously absorption of direct light and light diffused by the air forming a luminous haze and becoming a species of stray light. In pouring rain photometry became almost impossible, but apart from this condensed moisture, besides completely changing brightness-values determined on the road-surface, might affect the qualities of the test plate. It was surely

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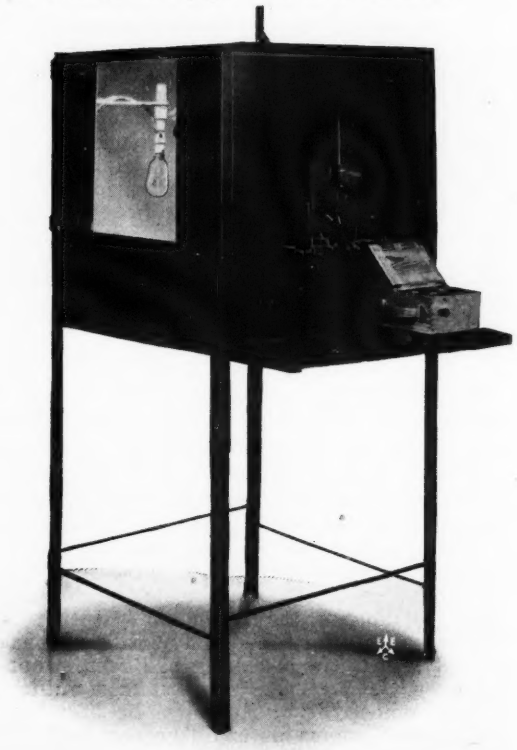

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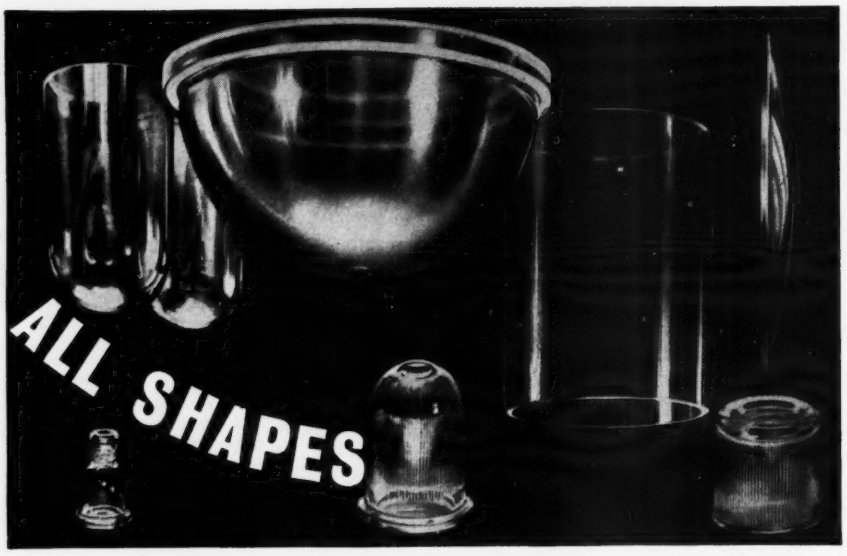

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asking a good deal in connection with maintenance contracts to ask parties to agree what were "satisfactory climatic conditions" in this country!

In conclusion, Mr. Dow remarked on the tendency, evident in the methods pursued in the M.O.T. street lighting reports as compared with the earlier B.S.I. Specification, to specify the candle-power of sources, used under specified conditions, rather than the measured illumination. One result might well be to revert to the earlier method of testing the candle-power of sources in connection with contracts—though for research and exploration tests of illumination and brightness would continue to be made. In this case one could conceive that much of the outdoor photometry of the future might be done in comfort in the shelter of a motor-van, housing both photometric and photographic equipment, and that for many purposes the travelling photometric laboratory might tend to replace the portable photometer.

After the chairman (Mr. J. M. Waldram) had called for a vote of thanks to Mr. Dow for his address there was a keen discussion, in the course of which photometric equipment for outdoor use, including some previously shown at the opening meeting, was exhibited and used to illustrate points in the discussion. Amongst those who so contributed were Mr. G. H. Wilson, Mr. S. S. Beggs, and Mr. R. Maxted. Mr. J. S. Preston and other speakers reported progress with photo-electric cells, and gave hopes of better results in the future, though Mr. G. H. Wilson stated that he had found it impracticable so far to use such methods for outdoor work.

The Hygiene of Outdoor Photometry.

Many useful practical points were illustrated by Mr. Wilson, who emphasised the inclement conditions to which those engaged in all-night photometry were often exposed, advocating the use of warm clothing, especially gloves, and knobs for instruments which could be manipulated by those wearing them! He also stressed the need for team-work in modern photometry, helpers being needed to illuminate scales, spirit levels, etc., by torches, and even, on occasion, to protect the test-plate with an open umbrella! He also quoted experiences of effects of absorption. Even with a fairly clear atmosphere, 25 per cent. of light was absorbed in a distance of about 200 ft. Mr. A. Cunnington, who represented what was afterwards described as the "lone wolf" school of outdoor photometry, instanced several processes involving the use of three hands and described devices for maintaining the test plate in position.

Photometric Reminiscences.

The chairman, in winding up the discussion, remarked that one feature of outdoor photometry was the tendency for all possible errors to arise together. A pleasing element had been the numerous recollections of amusing incidents scattered throughout this informal discussion. A profitable evening, devoted entirely to photometric reminiscences, might, perhaps, be arranged some time in the future.

Mr. Dow, in briefly replying to the discussion, recalled yet another such incident. During tests on flares conducted for the Ministry of Munitions during the war, one of the observers had been swept off his feet by a trailing rope attached to a military kite. It was some little time before he and his rather cumbersome apparatus could be reassembled in the darkness—a good illustration of the unforseen difficulties that were apt to hamper outdoor photometry.

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Street Lighting Notes

The contract for the gas lighting of the parishes of Streethouse and Ackworth (Yorks) has been renewed.

Gas lighting is being introduced in Axbridge, Somerset, under a new five years' contract.

Considerable improvements are being carried out in the lighting of Castletown (I.O.M.) as a result of a five-year agreement for gas lighting which has been entered into by the Castletown Commissioners. Reflectors are now fitted to all lamps and the candle power of lighting units is being raised.

The local authority concerned has entered into a contract for the lighting by gas of the villages of Milford and Witley, Surrey.

Bottesford, Notts, will continue to be lighted by gas as a result of a renewal of the agreement between the local authority and the gas undertaking.

Cononley Parish Council has decided to light the village by gas during the coming lighting season.

About 274 lamps are covered by a renewal of the agreement for gas lighting in Spennymoor.

The seventy-one miles of public lighting in the Borough of Widnes is entirely by gas, there being 1,499 public gas lamps. The total annual consumption of gas for the purpose is 22,967,737 cubic feet, and the annual maintenance costs £4,733.

Cowling Parish Council has renewed its contract for public lighting by gas.

More gas lamps are to be used on Farnhill's public lighting system as a result of a seven-year agreement in force.

The Garforth U.D.C. have entered into a ten-year agreement for an extension of the street lighting system by gas.

As a result of the new installation of gas lighting in Dunster residents are claiming to have the best lighted village in West Somerset.

The Potton Parish Council has renewed its agreement with the local gas undertaking for lighting a portion of the town.

A ten-year agreement for gas lighting in Dukinfield has been entered into by the Corporation. The contract covers some 653 lamps and embodies various improvements in the lighting.

Improvements are to be carried out in the lighting of Grayshott, Hants, as the result of a three-year contract for gas lighting arranged by the Parish Council.

The Wokingham, Berks, Lighting Committee have decided to fit automatic igniters to their all-night lamps, and if the experiment proves successful they will probably be installed in all lamps in the town.

Loddon Parish Council have agreed on a renewal of their contract for gas lighting in their area.

Improvements are being carried out in the lighting of Bishop's Waltham under the five-year agreement with the local gas undertaking.

Thaxted (Essex) will be gas-lighted during the coming winter as a result of a renewal of the contract between the Council and the local gas undertaking.

Swillington, Yorks, is to have a system of public lighting with gas. An agreement for a term of three years has been made.

Kingswood (Gloucestershire) Parish Council has renewed its contract for gas lighting in the streets under its control.

Automatic lighting devices and reflectors have been added to the 113 gas lamps used to light Chatteris. The agreement between the Council and the local gas undertaking has just been renewed.

Gas street lighting has been installed on a new housing estate erected by the Hawick Town Council.

A ten-year agreement for gas lighting has been made by the Crofton (Yorks) U.D.C. All lamps are fitted with automatic control.

Five years is the term of a recent street lighting agreement entered into by the Preston Parish Council.

Literature on Lighting

(Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

(Continued from page 281, November, 1938.)

I.—RADIATION AND GENERAL PHYSICS.

305. The Field of Luminous Flux.

G. W. O. Howe. El. Rev., Vol. CXXIII., No. 3,181, p. 679, November 11, 1938.

Examines a suggestion put forward at the 1937 International Illumination Congress by A. A. Gersun that one can apply to the problems of illumination the concepts and technique developed in connection with electric and magnetic fields. The article analyses this suggestion, and concludes that no advantages are gained, even if it is on a sound basis. R. G. H.

II.—PHOTOMETRY.

306. Phototubes Measure Output of Flash Bulb.

Anon. El. World, 110, p. 1062, October 8, 1938.

A detailed description is given of the circuit, using photoelectric cells, which has been adopted by a New York laboratory for measuring the magnitude, duration, and timing of the flash from photo-flash bulbs. A filter is used to correct the spectral sensitivity of the photocell which responds to the main flash to that of photographic film. S. S. B.

III.—SOURCES OF LIGHT.

307. Lamps and Lumens.

S. G. Hibben. El. Journal, Vol. 35, No. 10, p. 396, October, 1938.

Summarises the progress made in lamp production in the United States, resulting in a reduction in initial cost of lamps, and in an increase in the luminous output for given energy input. It is stated that about 20 per cent. of the generated electric power in the U.S.A. is expended on lighting. R. G. H.

308. Lifetime of U.V. Sunray Lamps.

E. Hasche. Das Licht, Vol. 8, No. 10, pp. 224 and 225, October 10, 1938.

Investigates variation in efficiency in relation to life of sunray lamps. In many cases 98 per cent. of the original U.V. Radiation intensity is retained after six months' use. H. L. J.

309. Product Problems—from Research to Application

R. N. Stoddard. El. Journal, Vol. 35, No. 10, p. 379, October, 1938.

Describes the Sterilamp, a long mercury-vapour discharge lamp, radiating in the 2550 A.U. region. Its use is in killing bacteria, etc., and has been applied to sterilising meat-storage refrigerators, hospital operating theatres, and other places where a sterilising radiator is required. R. G. H.

IV.—LIGHTING EQUIPMENT.

310. Floodlighting Reflector for Discharge Lamps.

C. Bauer. Das Licht, Vol. 8, No. 10, pp. 213 and 214, October 10, 1938.

A silver glass parabolic reflector of approximately 16 in. diameter is described. This gives a fan-like light distribution. Lamps consuming up to 1,000 watts may be used in either vertical or horizontal positions. The reflector is mainly provided for floodlighting at short distances. H. L. J.

311. New Anodic Aluminium Lighting Unit.

Anon. El. Times, 94, p. 444, October 6, 1938.

Describes with photograph an office with 14 ft.c. of totally indirect illumination. The fittings have 300-watt lamps, and are made of anodised aluminium. W. R. S.

312. Use New Material in Remodelled Front.

Anon. El. World, 110, p. 1066, October 8, 1938.

A description and photograph are given of a shop facia, using a new translucent glass consisting of a heat-treated plate glass panel with a letter and contrasting background colour of glass fused to the plain glass plate. Large panels can be made using this process. S. S. B.

313. New Equipment and Appliances.

Anon. Elect., 121, p. 449, October 14, 1938.

New lighting equipment now available include a close-to-ceiling diffusing bowl and a fitting for a staircase newel post. C. A. M.

314. Suez Canal Searchlight.

Anon. Elect., 121, p. 524, October 28, 1938.

Details with a photograph are given of a searchlight using a 3,000-watt incandescent lamp. C. A. M.

315. Fluorescent Lamp Auxiliary Devices.

Anon. El. World, 110, p. 1188, October 22, 1938.

Three types of auxiliary equipment for use with the low wattage fluorescent discharge lamps are described, being different forms of starting devices. The advantages and disadvantages of each type are summarised. S. S. B.

V.—APPLICATIONS OF LIGHT.

316. Revealing Quality of Lighting Measured.

H. M. Sharp and C. L. Crouch. El. World, 110, p. 1058, October 8, 1938.

Measurements have been made by the authors, in an attempt to evaluate the relative effectiveness in interior general lighting systems. Several systems were tested, and all fell far short of the ideal. Data on the results of the tests are given, and the authors give the opinion that sources of extended area are the most desirable S. S. B.

317. Lighting Engineers and Light Users.

"Pharos." Elect., 121, p. 512, October 28, 1938.

The author discusses the general difficulties the lighting engineer meets in finding the exact nature of his clients' requirements. Frequently problems arise with some factors that are probably unfamiliar to the engineer. C. A. M.

318. School Lighting Improved in 300 Classrooms.

Howard M. Sharp. El. World, 110, p. 1011, October 8, 1938.

The author gives some details of the improvements in classroom lighting being introduced in American schools, with a summary of the procedure which he considers most advantageous in promoting good school lighting by co-operation amongst the bodies concerned. S. S. B.

319. Small Town Hall has Advanced Lighting.

Horace W. Myers. El. World, 110, p. 1064. October 8, 1938.

A description is given of the lighting of a small auditorium, using recessed panels in the ceiling. S. S. B.

320. Solves Problems of Roundhouse Lighting.

Anon. El. World, 110, p. 1186, October 22, 1938.

Special units are described designed to withstand the corrosive atmosphere, smoke, and steam in railway engine sheds. The fittings are placed at a relatively low height and direct their light at an angle, so that adequate light is provided for work on any part of the engines. S. S. B.

321. Electric Lighting for Streets and Transport.

W. J. Jones. Beama, 43, No. 16, pp. 102-104, October, 1938.

A summary is given of the purposes of public lighting to which electric lamps have been placed in recent years. C. A. M.

322. Sodium Lighting on the Bath Road.

Anon. El. Times, 94, p. 550, October 27, 1938.

Photographs and a description is given of the first approved scheme under the Trunk Roads Act. Considerable use has been made of sodium lamps at 120-ft. spacing and 25-ft. mounting height. W. R. S.

323. Street Lighting Control.

Anon. Elect., 121, p. 577, November 11, 1938.

A method of street lighting control is described in detail with photographs and a diagram. C. A. M.

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324. Scheme Controls Dusk Street Lights.

A. L. Bennett. El. World, 110, p. 1182, October 22, 1938.

A circuit has been devised for use in series street lighting, whereby both "all-night" and "half-night" lamps may be operated from the one constant current transformer. S. S. B.

325. Lighting Technique on Railways.

E. Besser. Das Licht, Vol. 8, No. 10, pp. 207-212, October 10, 1938.

The author refers to the increasing difficulties in efficiently marking the 33,000 railroad crossings in Germany, and gives particulars of methods used and experiences gained. Experiments with a new barrier construction to increase reflection properties are described in detail. H. L. J.

326. Lighting with Fluorescent Tubes.

"Pharos." Elect., 121, p. 331, September 23, 1938.

A discussion is given on the possibilities of solving various lighting problems by means of fluorescent tubes. C. A. M.

327. Photographic Illumination.

T. Thorne Baker. El. Rev., Vol. CXXIII., No. 3,181, p. 681, November 11, 1938.

A general review of the needs of cinema and photographic studios, the illuminants available, and possible developments. R. G. H.

328. Recent Lighting Installations.

Anon. El. Times, 94, p. 531, October 20, 1938.

One floodlighting and three street lighting installations are described. At Dover the Castle has been illuminated with H.P.M.V. lamps. The street lighting installations described are the London-Bath Road (sodium lamps), Hanger-lane, Ealing (125-watt H.P.M.V. lamps), and Kuala Lampur (F.M.S.), where 250-watt H.P.M.V. lamps are installed. W. R. S.

329. Advanced Methods of Control Room Lighting.

W. B. Morton. El. World, 110, p. 1037, October 8, 1938.

The author deals with the problems which arise in lighting the control room of electrical plant. Both direct and reflected glare are materially reduced by using indirect lighting, especially in low rooms. Light-coloured panels have also proved beneficial in preference to the more usual black slate switchboard. Special lighting of the boards, where practicable, may be advantageous. Light colours and non-glossy surfaces should be used as far as possible throughout the room, and the elimination of windows may actually improve the visibility of the instruments. A combination of mercury vapour lamps and tungsten filament lamps appears very suitable for these rooms. S. S. B.

330. Horse Show Ring.

Anon. Magazine of Light, VII., No. 6, p. 22, September, 1938.

The lighting of the Detroit outdoor Horse Show Ring is produced by the alternate location of 1,500w-att Tungsten and 400-watt mercury units. C. A. M.

331. "Lighting" at the World's Power Conference.

B. Seeger. "Das Licht," Vol. 8, No. 10, pp. 218-221, October 10, 1938.

Lighting data are selected from contributions to the last World's Power Sectional Conference at Vienna and discussed, mainly in regard to circumstances relating to rural domestic electrification in the different countries. H. L. J.

332. Illumination at the Empire Exhibition, Scotland, 1938.

A. G. Bowd. G.E.C. Journal, IX., No. 4, pp. 244-251, November, 1938.

Details with numerous photographs are given of some of the chief exterior illumination schemes at the recent Empire Exhibition at Glasgow. C. A. M.

333. Lighting of Swimming Baths.

Anon. El. Times, 94, p. 571, October 27, 1938.

Four baths are illustrated and described. They are all equipped with underwater lighting units, which, it is suggested, is one of the most important applications of artificial lighting to the modern swimming-pool. W. R. S.

334. Indirect Lighting Returns to Stay.

Anon. El. Times, 94, pp. 475-476, October 13. 1938.

An illustrated description of the reconstructed lighting Service Bureau. Special mention is made of shop-window lighting, counter, lecture theatre, and stage lighting, as well as high intensity indirect lighting. W. R. S.

Recent Patents

(Abstracts of recent Patents on Illumination & Photometry.)

No. 491,257. "Improvements in or Relating to Lighting Fittings."

The British Thomson-Houston Company, Ltd., and Maxted, R. Dated March 15, 1937.

This specification covers a light fitting for a horizontally elongated light source comprising reflecting means above the source of light for reflecting the light outwards at an angle of about 78° to 82° to the vertical, and refracting panels having their top edges in line with the outer edge of the refracting means and the centre of the light source, the upper part of the refracting panels having a series of horizontal, straight-sided prisms for deflecting the light outward at an angle of about 77° to the vertical, the light from the said upper part and from the reflecting means passing through a series of horizontal prisms with curved sides forming the surface of a pair of flat glass plates oppositely disposed for spreading the light in the vertical plane, a lower part of the refracting panels having a series of horizontal prisms with curved sides for spreading the light falling on this part between angles of 16° and 72° to the vertical.

No. 491,738. "Improvements Relating to Artificially Cooled High-pressure Metal Vapour Electric Discharge Lamps."

Siemens Electric Lamps and Supplies, Ltd., and Aldington, J. N. Dated March 25, 1937.

According to this specification, a high-pressure metal vapour discharge lamp is immersed in a cooling liquid of which the circulation is promoted solely by the heat developed in the lamp. Guiding means, such as an open-ended cylinder, are provided for directing and enhancing the flow of liquid past the lamp.

No. 491,808. "Improvements in and Relating to Fluorescent Reflectors."

The British Thomson-Houston Company, Ltd. Dated March 9, 1936. *(Convention, Germany.)*

This specification covers a screen for metal vapour lamps and the like, consisting of two glass elements with an interposed plastic or solid layer of fluorescent material clamped together to form a three-ply structure, with the fluorescent material enclosed in an air-tight manner.

No. 492,075. "Improvements Relating to Guiding Lanterns."

Brown, A. G., and Paterson, C. C. Dated July 14, 1937.

This specification covers a guiding light or beacon suitable for use under air-raid conditions. The beacon comprises an opaque housing containing an electric lamp and having a small aperture formed in its lower side. A small reflecting device, such as a polished ball or cone, is disposed below the aperture and is surmounted by a screen so that light reflected from it in an upward direction is cut off.

No. 492,285. "Improvements in or Relating to Electric Incandescent Lamps."

The Nox Electric Lamp Company, Ltd. (Communicated by Dani, A. von, Austria.) Dated March 17, 1937.

According to this specification an incandescent lamp has an internal metal reflector in the form of an annular disc mounted in close proximity to an annular filament on the same pitch as the latter. The median line of the reflector coincides approximately with the projection of the filament on the reflector.

No. 492,286. "Improvements in Electric Incandescent Bodies for Producing Polarised Light."

Robert Bosch Aktiengesellschaft. Dated March 19, 1936. *(Convention, Germany.)*

A polarised light-producing incandescent body, according to this specification, comprises smooth, polished metal strips arranged in parallel or substantially parallel planes and in close propinquity to one another, the strips being so spaced that the emitted light is parallel or substantially parallel to the planes of the strips, and the rays make small angles of 0 to 30° with the emitting surfaces.

No. 492,626. "Improvements in Directional Lighting Fittings."

The General Electric Company, Ltd., and Smyth, J. B. S. Dated September 30, 1937.

According to this specification a directional light fitting comprises (1) a reflector above the source shaped so as to direct a substantial part of the light from the source into two beams, each substantially parallel in a plane perpendicular to the said axis, making a considerable angle to the said vertical plane, and one on each side of that plane; and (2) a bowl below the source, carrying on each side in the path of the said beams a plurality of prisms with their edges parallel to the axis of the source adapted to deflect the beams upwards through a substantial angle.

No. 492,712. "An Anode Material for Anodic Incandescent Lamps, and Method of Producing the Same."

Albiswerk Zürich Aktiengesellschaft. Dated March 20, 1936. *(Convention, Switzerland.)*

An anode material for an anodic incandescent lamp adapted to emit modulated light by electron bombardment has a cell structure reproducing vegetable or animal organisms, having cell walls of thickness less than 1-100 mm., and consists of a substance which does not evaporate or melt easily in vacuum. In the manufacture, salts of substances of high-melting point and low evaporation are introduced into the cell walls of a vegetable or animal body, and the organic substances are subsequently removed or consumed by combustion or chemically.

At the cross-roads -
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-consult BTH
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BTH Lighting Engineers — men who, since the advent of mercury electric discharge lighting, have tackled successfully some of the most difficult street lighting problems — are always available to give advice and to prepare complete schemes.
They are backed by the BTH Research Staff and the resources of a great Company manufacturing Street Lighting Equipment of unsurpassed quality
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THE BRITISH THOMSON-HOUSTON CO., LTD., CROWN HOUSE, ALDWYCH, LONDON, W.C.2.

Street Lighting Progress

Leicester.—A recent meeting of the Leicester City Council confirmed the Lighting Committee's recommendation to completely electrify all the street lighting in the city. The reason for this decision is twofold; first, on account of cost; and, secondly, in view of ease of control. Mr. Wilkie, Public Lighting Engineer, already controls approximately 90 per cent. of the main streets and roads in Leicester, which are lit by electricity from a central control panel at his headquarters. As electric street lighting extends this system will gradually be enlarged to embrace the whole town, by which time it will be possible to switch on all Leicester street lighting in a matter of approximately ten seconds, and to complete a black-out in approximately eighty seconds. The city council attaches great importance to this question of centralised control, which, it considers, is absolutely essential in connection with A.R.P. organisation.

Crook and Willington.—Considerable improvements have been made in street lighting in the Willington area of Crook and Willington U.D.C. In the summer months twenty-five 250-watt mercury discharge lamps were installed in this part of the area, replacing gas. In all, there are now seventy-seven mercury discharge lamps in the whole of the council's area, the majority having been installed during the past year.

Broughton, Lincs.—At a recent parish meeting it was decided by forty-five votes to twenty-two to reverse a recent decision, and, as a result, electric street lighting will be installed.

Deanshanger, Bucks.—At a recent parish meeting the Lighting and Watching Act, 1833, was adopted for the parish of Passenham-cum-Deanshanger. The clerk, in outlining the proposals to the meeting, said that the parish council recommended the provision of nine electric lamps at an estimated annual cost of £45 0s. 3d. In advocating the adoption of the Act, Mr. R. L. C. Ridgway, the district councillor, said that the neighbouring parish of Castlethorpe adopted the Act last year, and was already proposing to increase the number of lamps. The resolution was carried by 114 votes to twenty-seven.

Bethnal Green.—The Works Committee of the borough council has considered the question of providing centralised control of street lighting throughout the borough at a cost of £2,733 15s. The Electricity Committee has been requested to arrange for the installation of the system to be adopted initially in the East Ward of the borough. The capital cost will be defrayed out of savings on the current year's estimate for street lighting.

Bangor.—The lighting of the sea-front is to be carried out electrically, according to a recent decision of the council to accept the offer of the Electricity Board to erect and maintain twenty-one 250-watt mercury discharge lamps for the sum of £164 6s. 6d. per annum. Councillor M'Cullough was thanked for his special services in investigating the relative cost of gas and electricity for this purpose.

E.D.A.-E.L.M.A. Street Lighting Conferences

E.D.A.-E.L.M.A. Conferences on Street Lighting have recently been arranged at Wolverhampton (November 10), Leicester (October 28), and Cardiff (December 7). At Leicester, following some introductory remarks by the Lord Mayor, Mr. T. Catten dealt with progress in electric lamps, and an address reviewing street lighting was given by Mr. S. S. Beggs.

At Wolverhampton, Sir Charles Mander was responsible for the introductory address, after which Mr. N. L. Harris, with the aid of demonstrations, outlined the development of electric lamps. The now widely known film on Modern Street Lighting, developed in the B.T.H. research laboratories, was introduced by Mr. R. Maxted, after which Mr. M. B. Habershon, Borough Engineer of Walsall, opened a general discussion on economic and administrative problems.

At Cardiff, the demonstration of modern electric lamps was undertaken by Mr. C. R. Bicknell, after which Mr. G. H. Wilson gave a talk on Modern Street Lighting, in the course of which the conditions giving rise to good visibility were explained, and the carrying out of the recommendations in the M.O.T. final report discussed. Mr. A. D. Ridley, of Tenby, introduced the subsequent discussion on administrative and economic problems.

In each case opportunities of inspecting local street lighting installations were afforded after the various lectures.

New Lighting on Moss Bank Way, Bolton

A night view showing the appearance of Moss Bank Way, Bolton, lighted by 150-watt sodium Philora lamps in Revo fittings

We reproduce above a view of this new installation of sodium 150-watt Philora lamps in Revo fittings, brackets, and standards. The fitting is of a simple character embodying silvered mirror reflectors, which distribute the light very evenly over the roadway. Excellent visibility is secured.

Moss Bank Way is a new double bank arterial roadway, and has two 20-ft. wide carriageways, divided by a 4-ft. raised grass verge. The total width between the building line is 64 ft. A concrete roadway surface is provided.

One hundred and eighty units, mounted 25 ft. high and spaced at 52-yd. intervals by means of double arm and single arm brackets, are installed.

Decorative Lighting at Norwich

In the ancient East Anglian City of Norwich some pleasing lighting on the terraces of the new municipal buildings has recently been installed. Opal globes, coated on the inside with fluorescent material and housing 125-watt electric discharge lamps, are

G.E.C. ornamental lighting units equipped with Osira lamps installed along the Garden Terrace at the new Norwich Municipal Building

mounted on concrete pillars. In addition, eight 400-watt lamps in opal glass lanterns are mounted on tall standards in the vicinity of these buildings. In the market place new lighting with 400-watt Osira fluorescent lamps, housed in Di-Fractor lanterns and placed 25 ft. high, has been adopted.

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GAS GLOBES
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Will not run back. No wheels to get caught in. Sizes to 10 cwt. smallest wall space, side or front driving, also special types including multi-division barrels, combined horizontal and vertical operation.

The Illuminating Engineering Society (U.S.A.)

Notes on Transactions (Nov., 1938)

NEWS: *Next year's Convention will open at San Francisco,* on August 21, 1939, at the Golden Gate Exposition on Treasure Island. This year's Convention at Minneapolis was combined with an exhibition specially arranged to represent the latest developments in lighting equipment. Thirty-five manufacturers exhibited. At the Convention charters were presented to three new sections with headquarters in Dallas (Texas), Buffalo, and Minneapolis (Minn.). Immediately after the Convention the *National Lighting Sales Conference,* sponsored by the I.E.S. Committee on Lighting Service, was held. Fifty underground railway cars at Philadelphia have received a new lighting equipment composed of plastic material. *This equipment was found worthy of an "Honourable Mention" Award in the industrial classification of the Third Annual Modern Plastics Competition. A new type of traffic light* has been erected experimentally in The Hague. It consists of a large circular surface carrying twelve concentric neon tubes, six red and six green. If all six red tubes are lighted traffic is stationary; the transition to the green is effected by switching off one red ring after another, thus giving the road user an indication of the time still available before the change occurs. Experiments with devices are being made in Massachusetts. *A new 1,000-watt projection lamp* operating at a higher temperature and with 50 per cent. increased light output is to be introduced shortly. The lamp is designed to burn base downwards. It is specially intended to improve the efficiency of 16 mm. movies for commercial, technical, and home use. *Another new lamp,* involving a combined bulb and reflector in one, and available in two types, one giving a narrow beam and the other a wide beam, is also announced. The maximum overall length is $\frac{5}{8}$ in. These are developed for shop windows and also for local industrial lighting, etc.

SUBJECTS OF PAPERS: The Presidential Address by Professor H. B. Dates, entitled "The Development of an Art into a Science," summarises the Society's activities since the date of its foundation. Recent advances favour the establishment of a professional basis for illuminating engineering in the near future. Alterations in the constitution of the Society, making finer distinctions between qualifications of its members, are proposed.

"Thresholds and Supra-Thresholds of Seeing," by M. Luckiesh and F. K. Moss, gives an account of the authors' recent investigations in studies of psychological elements in relation to seeing and vision. Six thresholds of seeing are introduced: (a) Maximum ease of seeing—visual circumstances allow most comfortable process of seeing and optimum conservation of human resources. (b) Optimum—visual circumstances allow workers to neglect "cost of seeing." (c) Maximal certainty of recognition of critical details. (d) Minimal certainty of recognition of critical details. (e) Maximal certainty of distinguishing presence of an object. (f) Minimal certainty of distinguishing presence of an object. In further development of the measuring of visibility by the Luckiesh Moss visibility meter, the measuring unit of per cent. maximum visibility (P.M.V.), and the unit of relative visibility (R.V.), are introduced in connection with the definition and measuring of visual thresholds.

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NIPHAN
WATERTIGHT SWITCH PLUGS

For switchgear in exposed positions, we supply these watertight switch plugs. The INTERLOCKING type here illustrated has a machined faced, cast brass cover and cast iron base. The inlet is supplied either screwed or with gland.

The NON-INTERLOCKING type shown here is simpler but equally solid in construction. Either type is available for any amperage from 5 to 25. The full range of Niphan couplings and plugs for all purposes is described in our illustrated Catalogue No. 16C.

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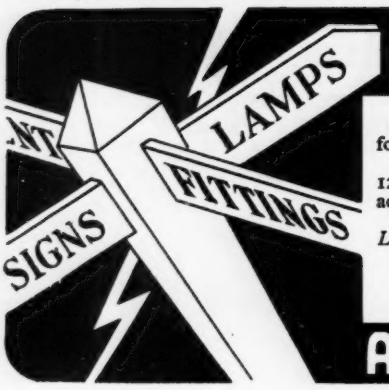

WHERE TO BUY

We invite applications for spaces in this new section of the journal. Particulars of terms for each space (approx. 1 inch deep and 3¼ inches wi .) are given below.

These terms are equivalent to **half our ordinary advertising rates,** but not less than 12 successive monthly insertions can be accepted on this basis, and amounts are payable in advance.

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3

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Pictures and Picture Galleries. Floodlighting, etc.
Decorative Fittings in Glass and Metal.

4

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5

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and BTH LIGHTING EQUIPMENT
Our Illuminating Engineers will be pleased to advise on any Street, Industrial or Floodlighting problem
THE BRITISH THOMSON-HOUSTON CO., LTD., Crown House, ALDWYCH, W.C.2.

6

BROMFORD
Seamless Steel Lighting Standards
for all requirements
BROMFORD TUBE CO., LTD., ASTON, BIRMINGHAM

7

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CONCRETE UTILITIES, Ltd., WARE, Herts.
The Firm with Experience.
Creators of the Popular Avenue Design.

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For all Lighting Problems—Cinemas, Works, Offices, Public Buildings, Country Houses.

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Spun Reflectors, Lamp Casings, Sheet-metal Work, etc.
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13

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DISCHARGE LIGHTING
FITTINGS FOR ALL PURPOSES

14

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PHOTO-ELECTRIC
BENCH, CUBE, STREET and PORTABLE TYPES
FOR CANDLE-POWER AND ILLUMINATION TESTS
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22

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LINOLITE
Reflectors for
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23

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THE LAMPLOUGH MATCHING LAMP
FOR ACCURATE COLOUR MATCHING
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34

"THORLUX"
"OVERLAMP" REFLECTORS
DISCHARGE OR GASFILLED LAMPS
SLIP-IT-ON SLIP-IT-OFF OVER THE LAMP FOR CLEANING
F.W. THORPE LTD. 39, BOLTON ROAD, SMALL HEATH, BIRMINGHAM.
FOR EASY MAINTENANCE - THE BEST

35

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36

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THE LIGHTING CENTRE LTD

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37

WARDLE ENGINEERING Co., Ltd.

OLD TRAFFORD, MANCHESTER, 16.

STREET LIGHTING EQUIPMENT. FLOODLIGHT PROJECTORS
WORKSLITE REFLECTORS. WARDELYTE GLASSWARE
PRISMALUX DIRECTIONAL UNITS.

We invite Enquiries from Readers or Particulars of "Wants" such as might be satisfied by Advertisers in this Directory

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N.B.—The numbers are those attached to individual entries in the Directory (See pp. 308-310)

E.L.M.A. 39th Illumination Design Course

The above course, held on consecutive Monday evenings from October 10 onwards and only recently concluded, was one of the most successful ever held. Applications for seats totalled 500 a few days before the opening day, and the number of seats allotted to one firm had to be reduced first to five and then to four. On the opening day over 300 attended in the newly extended lecture theatre at Savoy Hill. The analysis of attendances makes interesting reading. One notable feature is the good proportion of electrical contracting firms represented.

New Books Received

THE ELECTRICIAN'S POCKET BOOK, 1939. (Electrical Trading and Electricity. London.)

FLUORESCENCE AND PHOSPHORESCENCE. By E. Hirschlaff. (Methuen and Co., Ltd. London.)

Catalogues and Advertising Literature

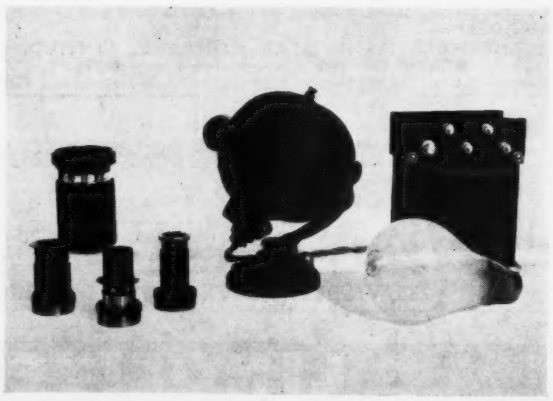
GENERAL ELECTRIC COMPANY, LTD.—The Osram G.E.C. Bulletin, October, 1938, contains many illustrated notes on modern lighting installations.

OSLER AND FARADAY, LTD.—Leaflet giving details of the new Faraday Magaphos series of lighting fittings.

PHILIPS LAMPS LTD.—"Selling Light" (November, 1938) contains an article on the nature of good lighting, and summarises Mr. Lingard's recent I.E.S. talk of American light practice.

SIMPLEX ELECTRIC COMPANY, LTD.—Leaflet describing Simplex Under-Floor Duct System.

A New Picture Lighting Projector



The above picture shows the essential parts of the "Britchard" picture lighting projector shown by Mr. Harold Bright at the recent I.E.S. opening meeting, and described in our last issue (p. 26, November, 1938). The transformer is shown on the extreme right. In the foreground is seen a selection of interchangeable lenses for throws of from 5 ft. to 50 ft. The worm and swivelling gear for the adjustment of direction of the projector may also be noted. The 40-watt lamp has been introduced on the right simply to give some idea of the very compact nature of this projector. A feature is the ease with which the field of light can be curtailed to conform to the area of the picture or other object to be illuminated.